National Aeronautics and Space Administration

Space Launch System
Highlights

July 2013

NASA's SLS Completes Preliminary Design Review

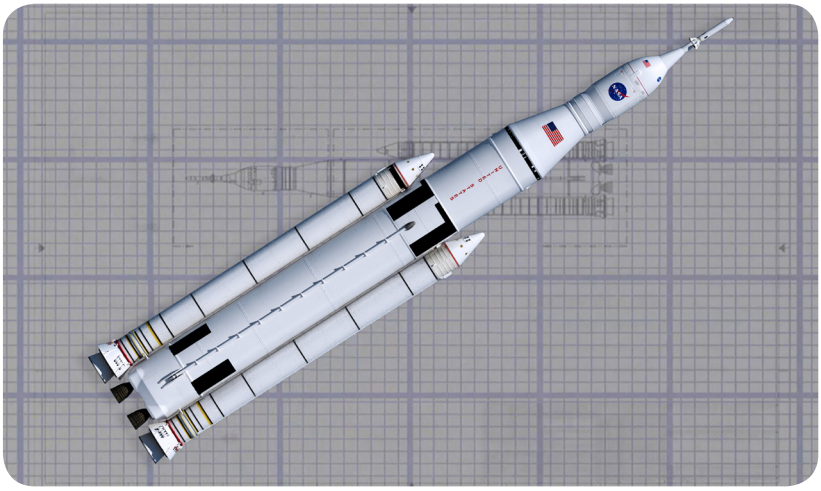
NASA has achieved a major milestone in its effort to build the nation's next heavy-lift launch vehicle by successfully completing the SLS preliminary design review (PDR).

Senior experts and engineers from across the agency concluded July 31 that the design, associated production and ground support plans for the SLS heavy-lift rocket are technically and programmatically capable of fulfilling the launch vehicle's mission objectives.

"The review had to be incredibly detailed, so our plans for vehicle integration, flight software, test, verification and operations will result in a safe, affordable and sustainable vehicle design," said Todd May, manager of the SLS Program at NASA's Marshall Space Flight Center in Huntsville, Ala.

This review concludes the initial design and technology development phase. The next milestone in the continuing verification process is Key Decision Point-C, in which NASA will grant the program authority to move from formulation to implementation.

"The agency not only reviews the program



Artist concept of the SLS design. *(NASA/MSFC)*

internally, but also seeks help from many external sources," said LeRoy Cain, head of the independent standing review board for SLS. "There are several external NASA stakeholders and organizations—including Congress, the Office of Management and Budget, and the public—who require a thorough, truly independent look at these programs as they transition through their lifecycle."

People from across the country, including experts on 11 different review teams, participated in the design review process, which included analysis of approximately 200 documents and 15 terabytes of data.

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NASA's SLS Completes PDR

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NASA's industry partners—The Boeing Company of Chicago; ATK of Brigham City, Utah; and Aerojet Rocketdyne of Sacramento, Calif.—also contributed to this successful checkpoint, and will continue to work to meet all program milestones.

In July 2012, the SLS Program completed a combined system requirements review and system definition review, which set requirements of the overall launch vehicle system. That successful completion confirmed the SLS was ready to move from concept to design. All element-level preliminary design reviews for the SLS core stage, boosters, engines, and spacecraft and payload integration have been completed successfully.

"In two short years from the first announcement of the Space Launch System, we are at a milestone that validates the detailed design and integration of the system," said Dan Dumbacher, deputy associate administrator for the Human Exploration and Operations Mission Directorate. "You can feel the momentum of the workforce as we produce test hardware today. We are creating a national capability, and we will get this country, and the world, exploring deep space."

From left, Anthony Antonelli, a NASA astronaut and SLS Program PDR board crew office representative, talks with Tony Lavoie, manager of the Stages Office, and Todd May, manager of the SLS Program, after signing the preliminary design review completion certificate. Some 20 NASA representatives signed the certificate, which acknowledges the SLS Program has demonstrated readiness to proceed to the next major milestone review. *(NASA/MSFC)*

Click **here** for more information on the SLS preliminary design review.

First Liquid Hydrogen Tank Barrel Segment for SLS Core Stage Completed at Michoud Assembly Facility

Engineers at NASA's Michoud Assembly Facility transfer a 22-foot-tall barrel section of the SLS core stage from the vertical weld center. The barrel section will be used for the liquid hydrogen tank, which will help power the SLS rocket out of Earth's orbit. *(NASA/Michoud)*

The first liquid hydrogen tank barrel segment for the core stage of SLS recently was completed at the agency's Michoud Assembly Facility in New Orleans.

The segment is considered a "confidence" barrel segment because it validates the vertical weld center is working the way it should. The vertical weld center is a friction-stir-weld tool for wet and dry structures on the SLS core stage.

Friction stir welding uses frictional heating, combined with forging pressure, to produce high-strength bonds

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Barrel Segment

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Click **here** to watch a video of the barrel completion.

virtually free of defects. The welding process transforms metals from a solid state into a “plastic-like” state and uses a rotating pin tool to soften, stir and forge a bond between two metal plates to form a uniform welded joint—a vital requirement of next-generation space hardware.

The Vertical Weld Center, completed in June, is welding barrel panels together to produce whole barrels for the core stage’s two pressurized tanks, the forward skirt and the aft engine section. The vertical weld center stands about three stories tall and weighs 150 tons.

The finished barrel segment stands at 22 feet tall, weighs 9,100 pounds and is made of Al 2219, an aerospace aluminum alloy. The segment will be used in structural tests to ensure the integrity of the piece. “This barrel section was welded as part of a plan to demonstrate new weld tool manufacturing capabilities and will be used for futher production tool confidence welding activities,” said Steve Holmes, manufacturing lead in the Stages Office at NASA’s Marshall Space Flight Center in Huntsville, Ala. “The first fully welded barrel segments are extremely important to test tools and manufacturing processes prior to start of qualification hardware and first-flight articles.”

Five similar barrels and two end domes will be constructed to make up the SLS core stage liquid hydrogen tank. Engineers from NASA and The Boeing Company have been conducting friction-stir-welding tests at Michoud to ensure quality and safety of flight hardware.

Spaceflight Partners: Irvine Electronics

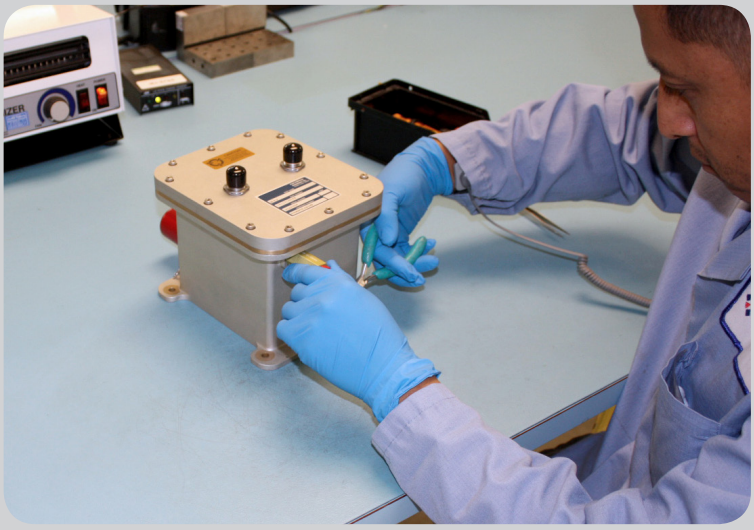
EDITOR'S NOTE: Every month, SLS Highlights turns the spotlight on one of the industry partners helping to create the largest rocket ever built for human space exploration. In this issue, we profile Irvine Electronics in Irvine, Calif.

Spectators are often in awe when they witness a live hot-fire test of the J-2X engine, marveling at the massive power thundering against their chests as fire and hot steam bellow from the stand.

One of the many components that make those tests possible is the Main Injector Exciter Unit (MIEU), an electronics system manufactured by Irvine Electronics Inc., a woman-owned business based in Irvine, Calif. The company builds the electronics package that creates the voltage to generate a spark, which in turn ignites the propellants to start the engine during test and future launch.

Four years ago, the company partnered with Aerojet Rocketdyne of Canoga Park, Calif., to supply the MIEU for the J-2X. Aerojet Rocketdyne is the prime contractor building the J-2X, which is an option being considered by NASA to power the upper stage of NASA's 130-metric-ton (143 ton) Space Launch System.

Established in 1990, Irvine Electronics provides electronics manufacturing services and specializes in turnkey assembly of everything from simple-printed circuit boards to highly complex complete box builds. It operates in a 50,000-square-foot facility with about 100 employees.



An Irvine Electronics employee works on the Main Injector Exciter Unit (MIEU), an electronics package that creates the voltage to generate a spark, which in turn ignites the propellants to start the J-2X engine during testing. *(Irvine Electronics)*

"Everyone here is extremely excited to know they are part of something larger than themselves, and that they have a responsibility for the safety of the astronauts who will be traveling on the SLS," said Toni Wilkerson, quality assurance manager at Irvine Electronics.

'Hammering' Out the Answer: How Much Impact Can Space Launch System Flight Hardware Handle?

To what extent will shock waves be attenuated—or reduced—when they travel through the forward skirt on the SLS? A common toolbox item may just hammer out the answer.

The forward skirt, a part of the SLS core stage, will house the avionics, including the flight computers, for the rocket. The skirt exterior will have two vehicle stabilization system brackets attached, allowing connection to the launch tower structure. The brackets and tower structure will stabilize the SLS until liftoff when it will be released instantaneously. The devices that will perform this release can generate high mechanical shock levels, which the SLS must be able to withstand.

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‘Hammering’ Out

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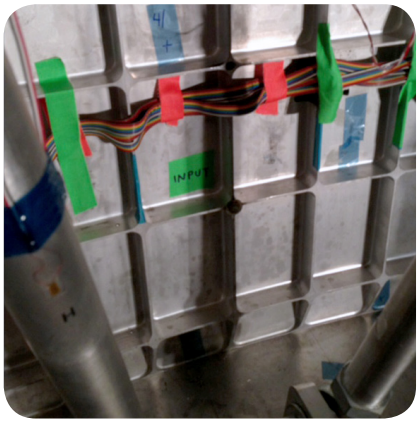
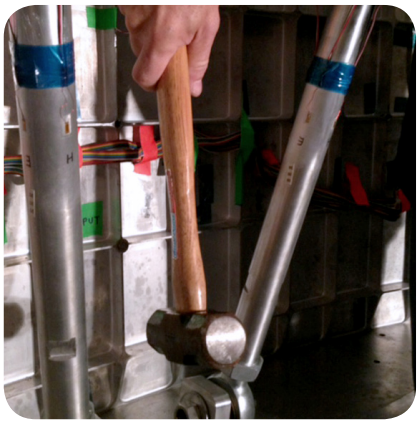
Engineers at NASA’s Marshall Space Flight Center in Huntsville, Ala., are using simple means—a hammer and a repurposed test article from another program—to simulate how much shock magnitude key components housed in the forward skirt may experience when the vehicle stabilization system brackets are detached from the launch tower structure.

During the test, accelerometers are affixed to the test article to measure the shock magnitude and frequency at various locations, including areas where flight-critical avionics are mounted. The shock simulating the release of the vehicle from the tower is generated by hitting the vehicle stabilization system bracket attachment location with a simple hammer.

“When the vehicle stabilization system is released instantaneously at liftoff of the SLS, it will create a shock environment, with a certain magnitude and frequency level—very similar to the structure being hit with a hammer,” said Charles Adams, a Jacobs systems engineer supporting Marshall’s Systems Design and Definition Branch. “We assess that magnitude and frequency at various locations and set a limit on the shock environment that the forward skirt can handle at its interface with the launch tower.”

In the 1970s, there were a number of tests on how shock attenuates in various structures, Adams said. Marshall engineers are using that empirical data as a basis for their analysis today. “Structures have changed a lot since then, and the ability to measure shock has gotten much better,” Adams said.





A repurposed test article and a hammer are being used to study how much shock the SLS forward skirt may experience when the hardware’s brackets are detached from the ground tower at launch. Accelerometers affixed to the test article measure the magnitude and frequency generated when the structure is hit with a hammer. *(NASA/MSFC)*

“We wanted to do this test to make sure our allowable shock levels are accurate and are as high as possible without forcing any changes to the current design and certification of the forward skirt-mounted components.”

Data from the shock test also will help determine what kind of release device will be used to disconnect the vehicle from the tower. Two release devices currently are being considered, including a frangible nut, which is a small explosive built into a nut and used during the space shuttle era.

The other option is a split-spool release device. The split-spool is two halves that look like a spool of thread, with wires wrapped around them. Two wire leads are held in place with solder, and when an electric current is put through the wires, the solder melts. The halves then move apart, and the bolt comes out. The split-spool release device produces very low shock and is commonly used on satellites.

The release device ultimately will be selected by engineers with NASA’s Ground System Development and Operations Program.

SLS On the Road…

Tom Erdman from the SLS Resident Management Office at NASA's Kennedy Space Center briefs the media during a June 27 pre-grand-opening media event for the space shuttle Atlantis exhibit at Kennedy's Visitor Complex. "We are designing a rocket that will be evolvable, sustainable and affordable for this country—and for the world," Erdman said. NASA's Marshall Space Flight Center sent the Exploration Systems Development Division/SLS exhibit to the June 29 grand-opening. More than 12,500 people visited the exhibit. *(NASA)*

SLS Assistant Program Manager Sharon Cobb talks to 250 students participating in a summer program July 16 at Jordan-Jackson Elementary School in Mansfield, Mass. The program was part of the Mansfield Summer Institute, an athletic/enrichment program for children in kindergarten through eighth grade. Cobb and SLS Strategic Communications Manager Kimberly Robinson were in the Boston area July 16-18 to conduct outreach activities and visit SLS vendors. *(Sun Chronicle)*

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